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Secondhand smoke presence in outdoor areas in 12 European countries

The TackSHS Project Investigators, Elisabet Henderson [a,b,c], Alessandra Lugo [d], Xiaoqiu Liu [d], Xavier Continente [a,b,e], Esteve Fernández [f,g,h,i], Maria J. López [a,b,c,e,*], Silvano Gallus [d]

[a] Agència de Salut Pública de Barcelona, Barcelona, Spain
[b] Consortium for Biomedical Research in Epidemiology and Public Health (CIBERESP), Madrid, Spain
[c] Departament de Ciències Experimentals i de la Salut (DCEXS), Universitat Pompeu Fabra, Barcelona, Spain
[d] Department of Environmental Health Sciences, Istituto di Ricerche Farmacologiche Mario Negri IRCCS, Milan, Italy
[e] Sant Pau Institute of Biomedical Research (IIB Sant Pau), Barcelona, Spain
[f] Tobacco Control Unit, Institut Català d'Oncologia, L'Hospitalet de Llobregat, Spain
[g] Tobacco Control Research Group, Institut d'Investigació Biomèdica de Bellvitge, L'Hospitalet de Llobregat, Spain
[h] School of Medicine and Health Sciences, Universitat de Barcelona, L'Hospitalet de Llobregat, Spain
[i] Consortium for Biomedical Research in Respiratory Diseases (CIBERES), Madrid, Spain

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ABSTRACT

Introduction: Secondhand smoke (SHS) causes morbidity and mortality among non-smokers.
Objectives: To investigate SHS presence in outdoor areas from 12 European countries and its association with country-level characteristics.
Methods: Cross-sectional study performed in 2017–2018 within the TackSHS project. We conducted a face-to-face survey on a representative sample of the population aged 15 years and older from 12 European countries: Bulgaria, England, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Portugal, Romania, and Spain. Out of 11,902 participants, 8,562 were non-smokers. SHS presence was assessed in selected outdoor areas and defined as respondents viewing someone smoking the last time they visited each setting within the last 6 months. A ranking score for outdoor SHS presence was assigned to each country based on the SHS presence in each setting. We used Spearman's correlation (r) and the Chi-squared tests to assess the relationship between SHS presence and country-level characteristics.
Results: Except for children's playgrounds (39.5%; 95% confidence interval, CI: 37.6%–41.3%), more than half of non-smokers reported SHS presence in outdoor areas: schools (52.0%; 95%CI: 50.2%–53.7%), stadia (57.4%; 95%CI: 55.4%–59.4%), parks (67.3%; 95%CI: 66.0%–68.5%), hospitals (67.3%; 95%CI: 65.8%–68.7%), public transport stops (69.9%; 95%CI: 68.6%–71.2%), bar/restaurant terraces (71.4%; 95%CI: 70.2%–72.6%), and beaches (72.8%; 95%CI: 71.4%–74.1%). Residents in Latvia showed the highest overall outdoor SHS presence rank, followed by Greece, and Portugal. Outdoor SHS presence was directly correlated to the country's smoking prevalence ($r = 0.64$), and inversely correlated to the Tobacco Control Scale 2016 overall score ($r = -0.62$), the socio-demographic index 2017 ($r = -0.56$), and Gross Domestic Product *per capita* 2018 ($r = -0.47$) ($p < 0.001$).
Conclusions: SHS presence is high in most outdoor areas in Europe, especially in countries with higher smoking prevalence and lower tobacco control performance. To address outdoor SHS exposure, our findings require considering smoking bans along with other strategies to reduce smoking prevalence.

1. Introduction

Secondhand smoke (SHS) exposure is a substantial contributor to preventable morbidity and mortality (Carreras et al., 2019). Non-smokers exposed to SHS are more likely to be diagnosed with chronic adverse health outcomes, such as lung cancer and heart disease. In the pediatric population, SHS exposure has been linked to asthma and other respiratory conditions (U.S. Department of Health and Human Services, 2006). Worldwide, 1.2 million deaths were attributed to SHS exposure in 2017, of which over 63,000 deaths were among children younger than 10 years old (GBD Risk Factor Collaborators, 2018; Carreras et al., 2019). In Europe, the burden of disease related to SHS

* Corresponding author. Servei d'Avaluació i Mètodes d'Intervenció (SAMI), Agència de Salut Pública de Barcelona (ASPB), Pl. Lesseps, 1, 08023, Barcelona, Spain.
E-mail address: mjlopez@aspb.cat (M.J. López).

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exposure ranged from 600 to 1,200 disability-adjusted life years (Hänninen et al., 2014).

Advocacy and policy efforts in Europe aiming to curb SHS exposure have mainly focused, if not exclusively, on indoor locations. The change in the social norm governing indoor areas has stimulated the voluntary adoption of similar rules for homes (Monson and Arsenault, 2017). Yet, indoor smoking bans have also led smokers to identify new venues for smoking, such as outdoor areas neglected in smoke-free regulations (Sureda et al., 2015). Consequently, banning or restricting smoking exclusively in indoor spaces might be insufficient to completely protect non-smokers from the harms of SHS exposure. We provide a supplementary table (Supplementary Table 3) with information on the smoke-free policies in 12 European countries for a range of indoor and outdoor areas and up to 2018.

Outdoor areas constitute significant spaces for SHS exposure. According to a systematic review on SHS in open and semi-open settings, $PM_{2.5}$ levels in most outdoor smoking areas exceeded the annual mean concentration recommended by the WHO Air Quality Guidelines. The clustering of smokers, low wind speeds, and partially enclosed areas contributed to higher SHS outdoor concentrations (Sureda et al., 2013). Available evidence has also shown SHS levels drift from outdoor areas (in building entrances and terraces of hospitality venues) to indoor areas where smoking is already banned (Kaufman et al., 2011; López et al., 2012; Sureda et al., 2012). Given these circumstances, the lack of smoking bans in some outdoor areas might result in more vulnerable groups, including children, people in deprived contexts, or people with asthma, being exposed to SHS. These groups may thus experience a disproportionate burden of harm from outdoor SHS exposures.

Beyond the toxic dimension of SHS exposure in outdoor areas, several other concerns have been stated regarding tobacco use in outdoor settings. Smoking in outdoor public locations increases the visibility of negative role models to youth, provides opportunities to smoke, and enhances smoking normalization and social acceptability (Alesci et al., 2003). Moreover, outdoor areas are also the most frequent location for European adolescent smokers to smoke (Lagerweij et al., 2019). Thus, the regulation of smoking in specific outdoor venues might not only reduce the opportunities for young people from smoking but also prompt smokers to make healthier decisions (Bloch and Shopland, 2000; Alesci et al., 2003; Thomson et al., 2009). Last, outdoor smoke-free policies could help reduce the pollution generated by cigarette leftovers, the most common form of littering (WHO, 2017; European Environment Agency, 2018).

To date, most of the studies documenting the prevalence of exposure to SHS in European countries were based on exposures occurring in indoor locations (Thyrian et al., 2010; Fischer and Kraemer, 2016; Lidón-Moyano et al., 2017; Rachiotis et al., 2017). One of the studies looking at SHS exposure both indoors and outdoors showed that, while SHS exposure in indoor settings was nearly absent, non-smokers still reported to be exposed in some outdoor areas after comprehensive smoke-free legislation (Sureda et al., 2015). Another study on a representative sample of children younger than 12 years in Spain reported one third of the children were exposed at the outdoor school or nursery entrance, with a higher exposure prevalence in those households of lower socioeconomic status (López et al., 2018). Support to extend smoking bans to outdoor areas has also been evaluated in some countries in Europe, finding that the majority favor banning smoking in outdoor areas. Estimates varied depending on the setting and smoking status, being the highest for children areas (i.e., playgrounds and school grounds; above 80%) and hospitals/healthcare centers (above 70%) (Gallus et al., 2012; Sureda et al., 2015; Fu et al., 2019).

Outdoor areas have been identified as a research priority in the future for tobacco control (Barnoya and Navas-Acien, 2013). Surveillance is fundamental to track progress towards eliminating SHS exposure. However, data on the magnitude and distribution of SHS exposure in different outdoor settings is limited (IARC, 2009; Barnoya and Navas-Acien, 2013; Sureda et al., 2013). There is also a lack of evidence of country-level differences in SHS exposure in outdoor venues across Europe. Therefore, in this study, we describe SHS exposure in selected outdoor settings in Europe and identify key country-level exposure determinants in outdoor areas.

2. Methods

Data were drawn from the TackSHS survey (Gallus et al., 2020; Amalia et al., 2021), a face-to-face population-based cross-sectional study coordinated by Mario Negri Institute (Milan, Italy) and conducted within the framework of the TackSHS Project (Fernández et al., 2020). The TackSHS survey was performed in 12 European countries: Bulgaria, England, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Portugal, Romania, and Spain. Data were collected between June 2017 and October 2018 (except Italy, where a pilot study was carried out November 2016) by DOXA, the Italian branch of the Worldwide Independent Network/Gallup International Association and its European partners. A total of 11,902 participants were surveyed.

Countries included in the TackSHS survey were selected to reflect the variations in the geographical distribution, *per capita* income, smoking prevalence, and tobacco control policies across Europe, and represented 79.2% of the whole European Union (EU) population aged 15 years or older. Participants were eligible if they matched the following criteria: (i) be at least 15 years old; (ii) reside in either of the 12 selected countries; (iii) be able to understand the TackSHS survey questionnaire translated to country-specific languages; and (iv) formally accept to participate in the study.

The TackSHS survey was approved by local Ethics Committees in each of the 12 countries. All participants were informed about the TackSHS survey through a structured information sheet and provided their consent to participate in the study. The study protocol was registered in ClinicalTrials.gov (ID: NCT02928536).

Sampling methods have been described elsewhere (Gallus et al., 2020). Briefly, multi-stage sampling was used in Bulgaria, Greece, Italy, Latvia, and Romania; stratified random sampling in Germany, Ireland, Poland, Portugal, and Spain, combining also quotas on sex, age, and social class in Ireland; cluster sampling in England, and quota method in France.

Participants were asked by trained interviewers about demographic and socioeconomic characteristics, smoking habits, and other tobacco-related variables in computer-assisted personal interviewing (CAPI). Non-smokers were either never smokers, those who reported not having smoked at least 100 cigarettes (also hand-rolled cigarettes) during their lifetime, or former smokers, those who reported having smoked at least 100 cigarettes in their life and were not smoking by the time they answered the questionnaire. Current smokers were smokers who reported smoking at the time they participated in this survey.

The primary outcome of interest was SHS presence in the last visit to different outdoor settings. Outdoor SHS presence was determined in terraces of restaurants and bars, public transport stops, outdoor areas of hospitals, outdoor areas of schools, parks, children's playgrounds, stadia, and beaches by asking non-smokers: "In the last 6 months, were people smoking regular cigarettes the last time you visited the following sites?". Categorical response choices were: "Never visited in the last 6 months", "Yes" and "No". Those having seen people smoking regular cigarettes in any of the above-mentioned settings accounted for SHS presence in that setting. We also checked if current smokers had smoked in these same settings by asking the following question: "In the last 6 months, did you smoke a regular cigarette the last time you visited the following sites?". Response choices were the same as for non-smokers. Those having smoked regular cigarettes in a setting accounted for outdoor smoking in that setting.

Out of 11,902 TackSHS survey participants, 8,562 were non-smokers and 3,340 were current smokers. Among non-smokers, 13 did not provide information on SHS presence outdoors and were excluded from the present analyses. Among current smokers, 14 did not provide

information about smoking outdoors and were also excluded from the analyses.

We assessed a series of country characteristics from different sources. The median smoking prevalence obtained in the same TackSHS survey was used to create two categories (Gallus et al., 2020): <31% (Germany, Ireland, Italy, Poland, England, Latvia); ≥31% (Bulgaria, France, Greece, Portugal, Romania, Spain). We classified countries based on their overall score in the Tobacco Control Scale (TCS) 2016, developed to systematically monitor the implementation of tobacco control policies at country-level across Europe (Joossens and Raw, 2016): ≥50 points (England, France, Ireland, Italy, Poland, Portugal, Romania, Spain), <50 points (Bulgaria, Germany, Greece, Latvia). We also classified countries into the four geographical European regions set by the United Nations M49 standard (Statistics Division, 1999): Northern (England, Ireland, Latvia), Western (France, Germany), Southern (Italy, Greece, Portugal, Spain), and Eastern (Bulgaria, Poland, Romania). We grouped countries into two categories according to their gross domestic product (GDP) *per capita* in euros, updated in 2018 (European Comission, 2018): ≥25.000€ (England, France, Germany, Ireland, Italy, Spain), and <25.000€ (Latvia, Romania, Poland, Portugal, Greece, Bulgaria). We used the socio-demographic index (SDI) from 2017, built by the Global Burden of Disease researchers, as an indicator of country-specific development status. This composite indicator derives from the geometric means of the indices of total fertility rate under the age of 25, mean education for those aged 15 and older, and the lag distributed income *per capita* (Global Burden of Disease Collaborative Network, 2018). SDI values ranged from 0 to 1, being 1 the score indicating health outcomes are at the maximum level of development (lowest fertility rates, most years of schooling, and the highest income *per capita*). Countries in this study were divided according to the SDI quintiles, all falling in the two highest levels of development: high SDI (England, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Spain); high-middle SDI (Bulgaria, Portugal, Romania).

We assigned a ranking score for outdoor SHS presence to each country. Based on the SHS presence in each setting, countries were scored from 1 (lowest) to 12 (highest). We obtained a total of eight scores per country, corresponding to the eight outdoor settings in the study. A final score was calculated as the average of scores of the eight settings.

In each country, we applied an individual weighting factor to produce national representative estimates of the general population in terms of age, sex, habitat (geographic area and/or size of municipality), and, in some countries, socioeconomic characteristics. For the overall sample, we used an additional statistical weight, with each country contributing in proportion to its population aged 15 years or over based on Eurostat 2017 (European Commission). We described SHS presence and smoking in outdoor settings providing relative frequencies (%) and their corresponding 95% confidence intervals (CI). Spearman's correlation (r) and Chi-squared tests were applied to analyze the associations between SHS presence outdoors and the different country-level characteristics. All analyses were performed using STATA 15.

3. Results

Out of 8,549 non-smokers with available information on SHS presence outdoors, 30.9% visited in the last 6 months children's playgrounds, 36.0% schools, 27.3% stadia, 57.7% parks, 45.1% hospitals, 53.4% public transport stops, 62.0% restaurant or bar terraces, and 46.6% beaches (Supplementary Table 1A; 1 B). The corresponding estimates for smokers were 31.0% for children's playgrounds, 35.7% for schools, 29,9% for stadia, 59.9% for parks, 44.9% for hospitals, 53.6% for public transport stops, 72.5% for restaurants or bar terraces, and 50.9% for beaches (data not shown in tables).

Fig. 1 provides the prevalence of SHS reported by non-smokers and the prevalence of smoking reported by smokers in the eight outdoor areas of the study. Among all outdoor settings, children's playgrounds had significantly lower SHS presence (39.5%; 95% CI: 37.6%–41.3%) and smoking (42.6%; 95% CI: 39.5%–45.8%); whereas, beaches had, except for terraces of bars and restaurants, significantly higher SHS presence (72.8%; 95% CI: 71.4%–74.1%) and smoking (85.2%; 95% CI: 83.4%–86.9%).

Outdoor SHS presence by country is shown in Fig. 2. Ireland had the lowest and Latvia the highest prevalence of SHS presence in schools (22.5% and 84.8%), stadia (30.4% and 91.2%), parks (45.2% and 92.2%), public transport stops (25.1% and 93.9%), terraces of restaurants and bars (32.4% and 93.5%), and beaches (40.9% and 95.6%). In children's playgrounds the prevalence of SHS presence ranged between 18.5% in Ireland and 73.5% in Greece, and in outdoor areas of hospitals between 46.0% in Poland and 93.3% in Greece. Further information regarding the distribution of subjects who visited each setting, and the prevalence estimates (with their corresponding 95% CI) of those who answered witnessing people smoking regular cigarettes, overall and by

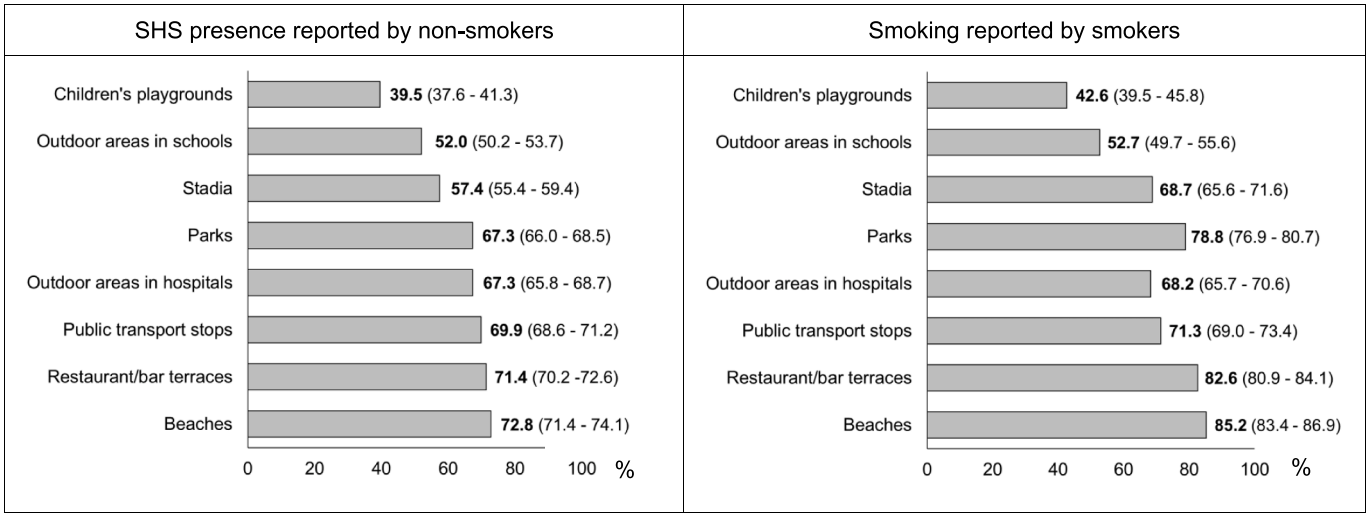

Fig. 1. Prevalence (%) and corresponding 95% confidence intervals (CI) of secondhand smoke (SHS) presence reported by non-smokers and of smoking reported by smokers that visited selected outdoor areas in the last 6 months in 12 European countries[a]. TackSHS survey 2017–2018. N = 11,902.
Base: For each setting, the respondents who visited that setting in the last 6 months and gave valid answers.
Note: Countries included in the survey are Bulgaria, England, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Portugal, Romania and Spain.
[a]A weighting factor is applied with each country contributing in proportion to its population aged 15 years or older.

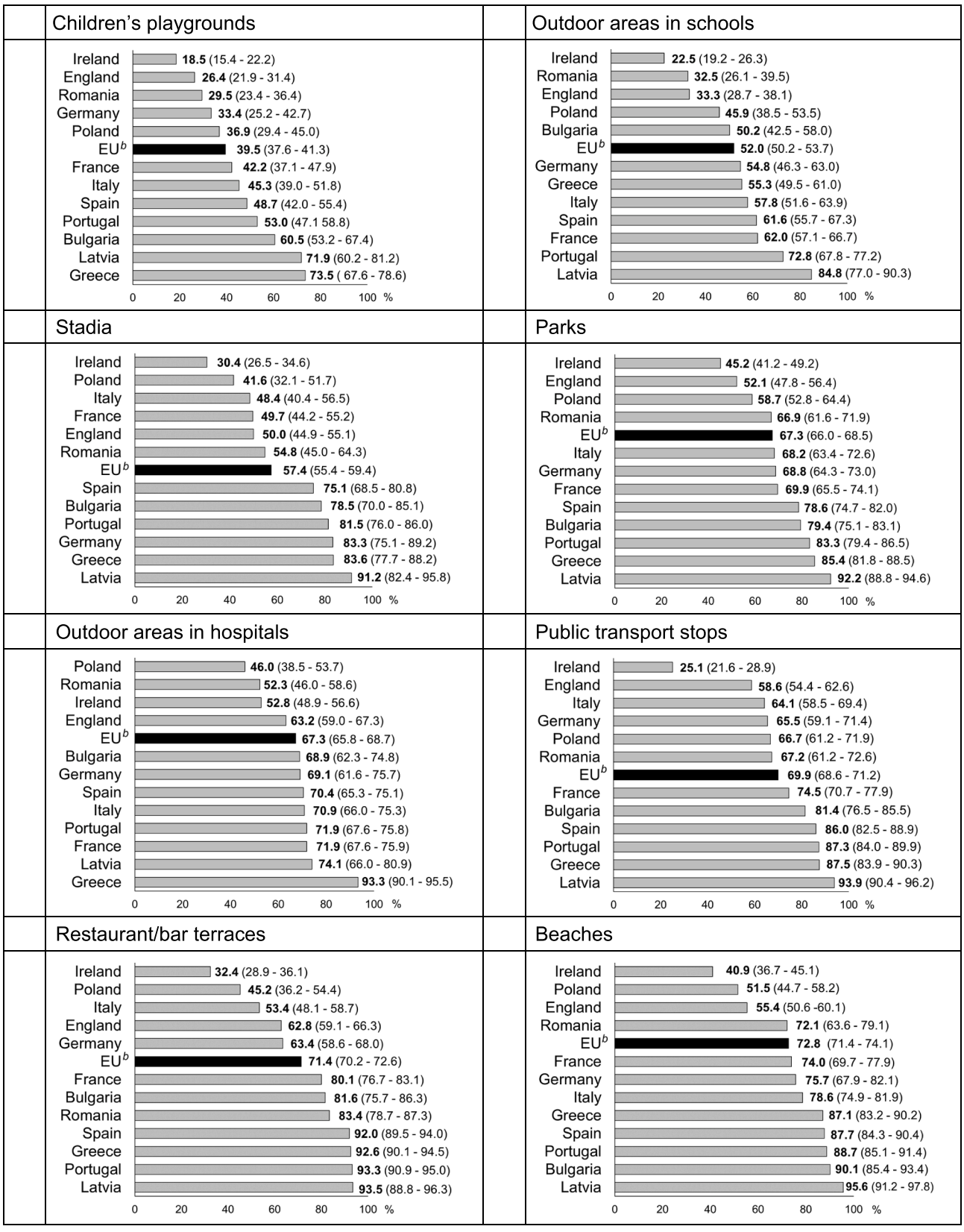

Fig. 2. Prevalence (%) and corresponding 95% confidence intervals (CI) of secondhand smoke (SHS) presence reported by non-smokers in various outdoor areas by country[a]. TackSHS survey 2017–2018. N = 7507.

Base: For each setting, the non-smokers who visited that setting in the last 6 months and gave valid answers.

[a] A weighting factor is applied with each country contributing in proportion to its population aged 15 years or older.

[b] EU: Overall secondhand smoke presence in the 12 European countries.

country, are summarized in Supplementary Table 2A and Supplementary Table 2B.

Table 1 displays the final rank score of outdoor SHS presence for each country together with the TCS 2016 scores, the SDI 2017 values, the GDP *per capita* in euros (2018), and the national smoking prevalence (2017–2018). By rank order, Ireland (average rank: 1.3), Poland (average rank: 3.0) and England (average rank: 3.1) had lower overall SHS presence in outdoor settings. Portugal (average rank: 10.0), Greece (average rank: 10.3) and Latvia (average rank: 11.8) had higher SHS presence overall. We found a strong inverse correlation between the overall SHS presence rank score and the TCS overall score ($r = -0.62$; $p < 0.001$); a moderate inverse association between the rank scores and the SDI values ($r = -0.56$; $p < 0.001$); a moderate inverse association between the rank scores and the GDP *per capita* ($r = -0.47$; $p < 0.001$), and a strong direct association between the rank scores and the country's national smoking (men and women combined) prevalence ($r = 0.64$; $p < 0.001$).

SHS presence in each outdoor setting according to different country-level characteristics is shown in Table 2. Countries scoring below 50 in the TCS 2016 had greater SHS presence in stadia (83.1%), parks (71.6%), hospitals (74.0%), and beaches (79.9%) than those scoring 50 or more (52.9%, 65.8%, 66.1% and 71.8%, respectively). All outdoor settings in countries with higher smoking prevalence had greater SHS presence ($p < 0.05$). Moreover, differences in the SHS presence were observed across geographic regions. In most settings, SHS presence estimates were lowest in the Northern region ($p < 0.05$). Countries with lower GDP *per capita* had higher SHS presence in children's playgrounds (45.3%), public transport stops (74.2%), and terraces of bars and restaurants (78.9%), but lower presence in outdoor areas of hospitals (61.8%). SHS presence in stadia (71.0%), parks (74.9%), public transport stops (78.0%), terraces of hospitality venues (87.8%), and beaches (83.8%) was more common in countries with lower development status.

4. Discussion

Our results suggest that many non-smokers in Europe face SHS presence in the outdoor environments they frequent. Except for children's playgrounds, more than half the non-smokers who visited the other outdoor areas in the study reported witnessing people smoking. This study also unveils marked differences in outdoor SHS presence across European countries and geographic regions. Overall estimates were inversely correlated to the country's degree of comprehensiveness of tobacco control policies, the SDI, and the GDP *per capita*; and directly correlated to the smoking prevalence.

In the same way, the present study provides the outdoor smoking prevalence reported by current smokers in the survey. The results obtained from smokers were close to, or even higher than, the reported SHS presence prevalence in each setting. Therefore, the estimates we show in this study are likely conservative measures of the actual SHS presence in outdoor areas in Europe.

Outdoor areas in hospitality venues and public transport stops were amongst the settings with the highest SHS presence. Unlike other types of outdoor settings, these are delimited spaces where people gather, especially smokers in outdoor areas of bars and restaurants (Sureda et al., 2015), and that can be partially enclosed. The well-accepted scientific consensus on the health risks of SHS exposure led to comprehensive indoor smoking bans across Europe. However, very few countries have banned tobacco use in outdoor public transport stops, and smoking in outdoor hospitality venues, when regulated, is still permitted if venues do not have overhead covers and more than two sidewalls. The high prevalence of SHS presence we observed in these settings indicates current regulations might not be enough to protect hospitality workers, patrons, and bystanders. The findings in this study align with another recent study showing that adolescents' visibility of smoking in Europe was high at train/bus stops (83.7%), bars/clubs (59.3%), and restaurants (55.4%) (Lagerweij et al., 2019).

We also show that nearly six out of ten non-smokers had seen people smoking in stadia. Exposure of stadium goers might resemble that in outdoor areas of bars, restaurants, and public transport stops. In stadia, however, SHS exposure might be even harder to avoid since supporters are close together for relatively long periods and seats are assigned (Bloch and Shopland, 2000). Moreover, despite smoking being incompatible with sportive success, tobacco has been long tied to sport events, making smoking behaviors appealing to youth. In this regard, legislation banning smoking in stadia have been adopted in Europe in the last years, most initiatives beyond national tobacco control regulations (Philpott et al., 2016; Philpott and Viggars, 2016).

SHS presence in playgrounds and schools was reported by four out of ten non-smokers in playgrounds, and half the non-smokers in schools. In agreement with our results is a study that measured SHS with objective environmental markers in playgrounds across Europe and found SHS presence in almost half of the sample (Henderson et al., 2020). However, tobacco presence around youth's learning environments might entail more than the health effects of breathing toxic components in the air. Viewing teachers smoking at school grounds, including outdoor areas, was associated with higher odds of students' smoking behavior (Poulsen

Table 1
Outdoor SHS presence ranking and country-level characteristics. TackSHS survey 2017–2018.

Country	Rank score[a]	TCS 2016	SDI 2017	GDP *per capita* (€) 2018[b]	Smoking prevalence (%)
Ireland	1.3	70	0.88	66,670	19.6
Poland	3.0	50	0.84	12,950	23.6
England	3.1	81[c]	0.85	36,480[c]	19.8
Romania	4.4	56	0.78	10,510	34.0
Italy	5.5	51	0.84	29,210	18.9
Germany	5.9	37	0.87	40,340	23.7
France	6.9	64	0.86	35,100	31.0
Bulgaria	7.9	47	0.79	7980	37.0
Spain	8.3	55	0.82	25,730	31.8
Portugal	9.9	50	0.78	19,870	36.8
Greece	10.3	40	0.82	17,210	33.8
Latvia	11.8	44	0.83	15,080	28.1
Spearman correlation	–	−0.6190 ($p < 0.001$)	−0.5626 ($p < 0.001$)	−0.4673 ($p < 0.001$)	0.6436 ($p < 0.001$)

Note: SHS, secondhand smoke; TCS, Tobacco Control Scale; GDP, Gross Domestic Product; SDI, Socio-demographic index.
Base: All non-smokers who had visited at least one setting in the last 6 months and gave valid answers.
[a] Outdoor SHS presence ranking: Each country was scored from 1 to 12 based on their SHS presence in each setting. The country with the lowest proportion scored 1 and the country with the highest proportion 12. We obtained a total of eight scores per country, corresponding to the eight sites in the study. Countries were ranked based on an average score obtained by adding the scores in each site and dividing by the total number of sites in the study.
[b] Eurostat database (accessed July 1, 2020).
[c] Data correspond to the United Kingdom.

Table 2
Secondhand smoke (SHS) presence reported by non-smokers and contextual factors in outdoor areas. TackSHS survey 2017–2018.

Characteristics	Children's Playgrounds	Outdoor areas in schools	Stadia	Parks	Outdoor areas in hospitals	Public transport stops	Restaurant/bar terraces	Beaches
	%[a] (n)[b]	%[a] (n)[b]	%[a] (n)[b]	%[a] (n)[b]	%[a] (n)[b]	%[a] (n)[b]	%[a] (n)[b]	%[a] (n)[b]
TCS 2016								
≥50 points	38.6 (777)	51.4 (1162)	52.9 (990)	65.8 (2263)	66.1 (2069)	69.7 (2280)	72.2 (2696)	71.8 (2138)
<50 points	44.5 (397)	55.0 (417)	83.1 (415)*	71.6 (1293)*	74.0 (693)*	71.2 (1000)	68.6 (1116)	79.9 (793)*
Smoking prevalence								
<31%	34.1 (416)	45.3 (601)	54.6 (607)	62.3 (1612)	64.1 (1256)	61.9 (1256)	59.2 (1324)	66.7 (1261)
≥31%	46.2 (758)*	59.8 (978)*	60.8 (798)*	74.8 (1944)*	71.3 (1506)*	79.1 (2024)*	85.9 (2488)*	80.8 (1670)*
Geographic area								
Northern	25.7 (234)	32.6 (357)	48.2 (411)	52.3 (853)	62.3 (774)	56.5 (731)	60.7 (822)	54.5 (611)
Western	39.6 (183)	59.8 (307)	60.1 (240)	69.3 (609)	71.0 (435)	71.4 (554)	72.4 (738)	74.5 (422)
Southern	49.9 (549)	60.6 (721)	66.1 (563)	75.1 (1376)	72.7 (1177)	78.4 (1386)	79.0 (1765)	83.0 (1474)
Eastern	37.1 (208)*	42.7 (194)*	48.6 (191)*	63.3 (718)*	50.2 (376)*	68.1 (609)*	65.5 (487)*	58.8 (424)*
GDP *per capita* (€) 2018								
≥25,000 euros	38.0 (580)	52.3 (862)	56.7 (782)	66.7 (1814)	68.4 (1621)	68.8 (1607)	70.2 (2104)	73.5 (1677)
<25,000 euros	45.3 (594)*	50.4 (717)	61.4 (623)	69.7 (1742)	61.8 (1141)*	74.2 (1673)*	78.9 (1708)*	69.3 (1254)
Socio-demographic index 2017								
High SDI	39.1 (853)	51.9 (1173)	56.5 (1059)	66.6 (2659)	67.6 (2157)	69.2 (2413)	70.2 (2838)	72.1 (2267)
High-middle SDI	43.3 (321)	52.4 (406)	71.0 (346)*	74.9 (897)*	63.1 (605)	78.0 (867)*	87.8 (974)*	83.8 (664)*

Note: SHS, secondhand smoke; TCS, Tobacco Control Scale; GDP, Gross Domestic Product; SDI, sociodemographic index.
Base: For each setting, all non-smokers who had visited at least one setting in the last 6 months and gave valid answers.
[a] A weighting factor is applied with each country contributing in proportion to its population aged 15 years or over.
[b] n: number of non-smokers having seen someone smoking. TCS: ≥ 50 points (England, France, Ireland, Italy, Poland, Portugal, Romania, Spain), <50 points (Bulgaria, Germany, Greece, Latvia). Smoking prevalence: < 31% (Germany, Ireland, Italy, Poland, England, Latvia); ≥31% (Bulgaria, France, Greece, Portugal, Romania, Spain). Geographic regions: Northern (England, Ireland, Latvia), Western (France, Germany), Southern (Greece, Italy, Portugal, Spain), Eastern (Bulgaria, Poland, Romania). GDP *per capita*: ≥ 25,000 (England, France, Germany, Ireland, Italy, Spain); < 25,000 (Bulgaria, Greece, Latvia, Poland, Portugal, Romania). Sociodemographic index: High SDI (England, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Spain); High-middle SDI (Bulgaria, Portugal, Romania). Chi-squared test: estimates with * are statistically significant based on the 95% Confidence Intervals.

et al., 2002; Escario and Wilkinson, 2018). It is important to notice that Europeans most likely start smoking at school age. According to the Eurobarometer (2017), more than half the smokers in Europe started smoking between the ages of 15–18 years (European Comission, 2017). Moreover, while the trends in smoking initiation decreased among adults and older adolescents, the trend in early adolescents (between 11 and 15 years) had significantly increased after 1990 in Europe (Marcon et al., 2018). European Commission Council Recommendations (2009) already called Member States to implement smoke-free policies with supporting actions to protect youth. Our results clearly evidence parties should undertake additional preventive measures and better enforce the existing policies in child-related outdoor environments.

Above 65% of non-smoking respondents reported SHS was present in the outdoor areas of hospitals, a setting that should play an exemplary role in promoting healthy lifestyle practices (Fernández and Martínez, 2010) and where smoking, behavior going on the opposite direction, is at the very least, counterproductive. Smoking bans including the outdoor premises of healthcare facilities are scarce and might not be well enforced. Roughly half the non-smokers surveyed in Poland and Ireland witnessed people smoking on hospital grounds that are already smoke-free by law. In Spain, a study evaluating the implementation of smoke-free hospital campuses found most outdoor areas (62%) to be free from smokers (Sureda et al., 2014). Conversely, our results point towards a limited compliance in outdoor areas of hospitals in Spain, underscore the need to adopt measures to improve law adherence in all countries where smoking is forbidden, and highlight the importance to extend the smoke-free legislation to hospital campuses in several other countries.

Approximately seven in ten respondents reported that there were smokers in their last visit to parks and beaches. For many smokers, discarding cigarette leftovers is still an acceptable form of littering (WHO, 2017). Based on recent data from the European Environmental Agency Marine Litter Watch, cigarette butts and filters were the most frequent pieces of litter on European beaches, making up a fifth of the debris found (European Environmental Agency, 2018). Furthermore, tobacco product waste is hazardous to the environment (Slaughter et al., 2011; Wright et al., 2015; Green et al., 2019) and local governments and taxpayers still bear most or all clean-up and disposal costs (WHO, 2017).

We have also observed clear disparities in SHS presence outdoors between European countries. Over the past decades, tobacco control has shifted from exclusive jurisdiction of the European Member States to a shared responsibility within the European Union. Subsequently, there has been an acceleration and harmonization in the adoption of tobacco control policies across countries. However, progress in the development of tobacco control regulations not subject to the EU diverged considerably (Joossens and Raw, 2016) as well as the national smoking prevalence trends. National smoking prevalence among the countries in this study ranged from 18.9% in Italy to 37% in Bulgaria (Gallus et al., 2020). Previous research has shown EU Member States with more comprehensive tobacco control policies had lower national smoking prevalence and higher relative decreases in the smoking prevalence from 2006 to 2014 (Feliu et al., 2019). In our study, rank scores on SHS

presence outdoors were directly related to the countries' smoking prevalence and inversely related to the TCS overall scores. Still, most national measures overlook SHS exposure in outdoor settings, and in the TCS 2016 no points were based on outdoor smoking bans. In this context, the association we observe between SHS presence outdoors and smoking prevalence highlights the importance of implementing tobacco control policies aiming directly at declining smoking prevalence. These measures are particularly relevant in Europe, where one the highest prevalence of tobacco use has been reported in adults and adolescents (WHO, 2017). By targeting a reduction in tobacco use rates SHS exposure outdoors would be better addressed.

Our results also suggest the adoption of more comprehensive tobacco control policies might have resulted in a lower acceptability of smoking even in settings where smoking is not forbidden, similar to the positive spillover effect also described at homes (Monson and Arsenault, 2017). Nevertheless, this might not be the case for terraces in hospitality venues, where a displacement of tobacco consumption from indoor areas to outdoors has been previously documented (López et al., 2012). Terraces are popular spots for smoking ever since indoor smoking bans at hospitality venues were enacted. Thus, SHS presence in this outdoor setting might reflect the differences in smoking prevalence among the countries in the study.

We found an inverse relationship between our ranking on SHS presence outdoors and the GDP *per capita* in 2018. Countries with a higher standard of living, as indicated by higher GDP *per capita*, generally adopt more progressive legislation, such is the case of Ireland, the first EU country to have comprehensive legislation banning smoking in indoor settings (Fong et al., 2006). Although all European countries fall in the two highest levels of development according to the GBD SDI in 2017, we show higher outdoor SHS presence in countries with lower development status. These results are consistent with our findings on outdoor SHS presence and the GPD *per capita*, another proxy of economic development.

For most of the outdoor settings in the survey, SHS presence was lowest in the Northern, and highest in the Southern countries in Europe. These differences were especially acute in child-related settings and suggest an increased awareness of the harms of tobacco use around children in the Northern regions of Europe. Nonetheless, these results should be interpreted with caution, since Latvia is the country with the highest overall rank score for outdoor SHS presence. In accord with our previous findings, Gravely et al. (2017) evidenced marked differences in the deployment of WHO FCTC measures targeting tobacco use reduction (e.g. Articles 6, 8, 11, 13, and 14) and smoking prevalence trends from 2005 to 2015 among UN geographic regions. Notably, countries in the Northern region of Europe had achieved a high degree of implementation after the first decade of the treaty and experienced greater reductions in smoking prevalence than other geographic regions worldwide.

This study is limited by the self-reported data and the 6-months recall window, both prone to information bias. However, considering the attendance to several outdoor areas might be subject to seasonality and weather conditions, the 6-month period of recall might prevent those biases. Moreover, SHS presence in wide spaces, such as outdoor areas, might be susceptible to the respondent's awareness of smoking. Even so, we have assessed the main outcome of our study following a similar question included in the Eurobarometer (European Comission, 2017). This study is also limited by the sampling methodology and the participant's age ranges as they slightly differed among countries. However, we have applied weighting factors in the analyses to assure the sample is representative of each country's population aged 15 years or over.

This is a multi-country study that includes a large sample size from 12 strategically chosen European countries. Participants were selected to obtain representative estimates of the adult population in each country. Besides, the survey was conducted based on a standardized protocol to ensure international comparability. Another strength of our study is the use of face-to-face computer-assisted interviewing by trained interviewers. Finally, to the best of our knowledge, this is the first study to provide detailed information on outdoor SHS presence and its association with contextual factors at a European level.

In conclusion, the findings in this study are another proof that SHS exposure at several outdoor settings is not to be neglected. Our results point to an urgent need to ban smoking or better enforce smoke-free policies outdoors at child-serving settings and hospitals, given that they are frequented by the most vulnerable population. For ecological reasons, smoking bans should also be implemented at beaches where SHS presence was highly prevalent. SHS exposure remains a relevant risk factor in terraces of hospitality venues, where the concentration of a large number of smokers in delimited spaces means exposure levels could still be very high. Therefore, a total ban for terraces should also be enacted to fully protect non-smokers. Finally, to effectively address outdoor SHS exposure, our results require considering not only smoking bans but also broader tobacco control measures targeting a decline on the prevalence of tobacco use across Europe.

Ethics Committees

Approvals of study protocol from Ethics Committees were obtained in the 12 European countries. Bulgaria (Ethics Committee of Bulgaria Sociological Association, 29/06/2017); England (Imperial College Research Ethics Committee, 17IC4241, 21/11/2017) France (Comité de Protection des Personnes Ouest III, 2017-A01860-53, 9/10/2017); Germany (Ethics Committee Hamburg Medical Chamber, PV 5718, 24/01/2018); Ireland (Dublin Institute of Technology, REC-17-40, 20/09/2017); Greece (University of Athens, 24/01/2018); Italy (Fondazione IRCCS Istituto Neurologico "Carlo Besta", n. 30, 8/06/2016); Latvia (Central Medical Ethics Committee of Latvia, 2/17-09-28, 28/09/2017); Poland (Ethics Committee of Health Care College, 1/2018, 28/06/2018); Portugal (Institute of Education, University of Minho, SECVS 026/2017, 31/10/2017); Romania (Comisia de Bioetica a Medicamentului si a Dispozitivelor Medicale, 7SNi, 7/6/2017); and Spain (Bellvitge University Hospital, PR149/17, 20/7/2017).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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Credit author statement

Elisabet Henderson: Formal analysis, Writing – original draft, Visualization. Alessandra Lugo: Methodology, Data curation, Validation, Writing – review & editing. Xiaoqui Liu: Methodology, Data curation, Validation, Writing – review & editing. Xavier Continente: Validation, Writing – review & editing. Esteve Fernández: Validation, Writing – review & editing. Maria J. López: Conceptualization, Writing – review & editing, Supervision. Silvano Gallus: Conceptualization, Writing – review & editing, Project administration, Funding acquisition.

Disclaimer

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